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Agricultural Memorandum No 1094

Weather Conditions and Low Winter Wheat Yields in 1987

Summary

This note is an addition to Ag Memo 1034 which described weather conditions in 1984 which led to the high wheat yields in that year. The coincidence of weather and crop growth stage are discussed and the possible effects on growth and yield are inferred. A new feature is the use of a wheat growth model to discuss the direct effects of weather on crop growth.

Introduction

Winter wheat yields in 1987 were reported as lower than in 1986 in many areas. Farmers Weekly for 25 September 1987 suggested that in 1987 the wheat yields were about 6.2 t/ha whereas in 1984 they were nearer 10 t/ha in East Anglia. Estimates of wheat yield by the National Farmers Union put the UK total at 12.5 mt in 1987 compared with 13.9 mt in 1986 (a 10% reduction).

Data

Weather data from Honington were used since the initial enquiry came from E Region. A graph (fig 1) was prepared using Weekly Weather Notes and MORECS, which shows the departures from weekly mean temperatures, and sunshine and rainfall expressed

FH2B.

as a percent of the average for each week. The MORECS soil moisture deficit for winter wheat growing on medium AWC soil is plotted for the MORECS square containing Honington (square 141).

Estimation of Crop Growth Stage and Dry Matter

The stage of development of the wheat plant main shoot apex was estimated from TSUM maps (square 141) by means of a model of wheat development which is summarised below:-

1. Sowing to emergence takes 120 °C days (base o°C)
2. Maximum leaf number N is estimated from $N = 9.08 + 0.81\ (T.D)/20$

   where T = mean air temperature 6 weeks from sowing

   D = daylength 3 weeks from sowing

3. The thermal time Tt (base 0°C) required between the same stage of successive leaves is given by

   $1/Tt = 0.0104 + 0.026\ (dD/dt)_{em}$

   where $(dD/dt)_{em}$ is the rate of change of daylength (in hr/day) at crop emergence

4. Double ridges is at 0.5N leaves
5. Terminal spikelet is at 0.68N leaves
6. Anthesis is at (N + 2.5) leaf equivalent
7. Maximum dry weight is at (anthesis + 743) °C days

These growth stages are marked on figure 1 for an early October sowing. Some idea of the range of the stages is also shown.

Crop dry matter growth was estimated by a simple wheat growth model which calculates growth assuming that there is no restriction due to weeds, disease and lack of water. The basic steps are:-

1. Leaf area index is calculated using an empirical relation between thermal time from sowing and LAI.

2. Incident solar radiation is calculated from sunshine hours and the fraction absorbed by the crop is calculated using LAI and an absorption coefficient.

3. Dry matter production is then calculated using an empirical efficiency which relates dry matter production to absorbed radiation.

4. The effects of nitrogen application are included by altering the maximum LAI achieved and also the efficiency of conversion of radiation to dry matter. All this nitrogen is assumed to be applied in Spring up to the terminal spikelet stage.

The model requires weekly means of air temperature, sun hours and the Cowley 'B' coefficient as input data. These were obtained from the Weekly Weather Notes, except Cowley 'B' which was from Met Mag No 1277 (December 1978) vol 107 pp 357-373. The dry matter which is calculated is therefore a potential value which only depends on the pattern of temperature and sun.

The Weather Sequence

The numbers are also on fig 1.

1. Sowings made in 3rd and 4th weeks of September went into dry seedbeds. This would have caused a patchy or delayed emergence. Wet weather then predominated

in a mainly mild autumn. The return to capacity date was a few weeks earlier than average.

2. A cool period during the ear formation period is generally beneficial.

3. The latter part of the ear formation period was warm which was not good timing.

4. Prolonged dull weather during the latter part of stem extension and grain growth phases is not good. Anthesis (or the attempt to do it) coincided with the coldest and wettest week available in June/July.

5. Just as the grain was ripening there was heavy rain which flattened crops and returned the soil to capacity (about 2.5 months early). The wet soils and further rain delayed harvest, while strong winds had severe effects in mid-September in areas where wheat could not be combined before that date.

Dry Matter Growth

The course of dry matter production is shown in fig 2 for 1987, 1986 and 1984. Although 1987 had a cold spring which delayed crop growth, the mild autumn in 1986 partly redressed the balance. Spring 1986 was also cold but without the very mild Autumn. Consequently, crop growth in 1987 'took-off' before 1986. However, the dull summer weather in 1987 reduced growth during several weeks, but in 1986 crop growth was maintained at a high level during the same period. The net result is that the total dry matter produced in 1987 is about 1 t/ha less than in 1986. In terms of grain yield this is about 0.5 t/ha less in a total potential yield of 13.9 t/ha (in 1986). The surprise is the final yield in 1984 which is well below both 1986 and 1987, although the rate of growth in June and early July is high. The main reason

for a lower calculated yield in 1984 is a shorter grain filling period due to higher temperatures than in the same period in 1986 and 1987.

Management Factors

In Ag Memo 1034 the interactions of crop management and weather were thought to be important in determining the harvested yields in 1984. Favourable weather for spraying and at harvest especially, were thought to contribute to the high harvested yields in that year. In 1987 apart from the latter part of April conditions were difficult for field work and crops were badly lodged by heavy rain in August. Any crops which were standing were also battered by strong winds, for example wheat losses in Northumberland were put at 1.3 t/ha due to wind between 14-19 September 1987. (Farmers Weekly September 25, 1987). The cold, dull, wet weather in June had a major effect on some varieties of wheat (notably Moulin and Mission) which considerably reduced the grain number which set. The growth model clearly shows the reduced growth rate during June.

Conclusions

The weather sequence in 1986/87 although not continuously favourable as it seemed to be in 1983/84 did have some features which were favourable (eg cool weather during much of stem/ear growth). The poor weather in June and especially round anthesis was not favourable, and the dull weather in much of May, June and July caused low growth rates. Rain and wind during the ripening and harvest phases seems to have had a major effect in reducing harvested yields.

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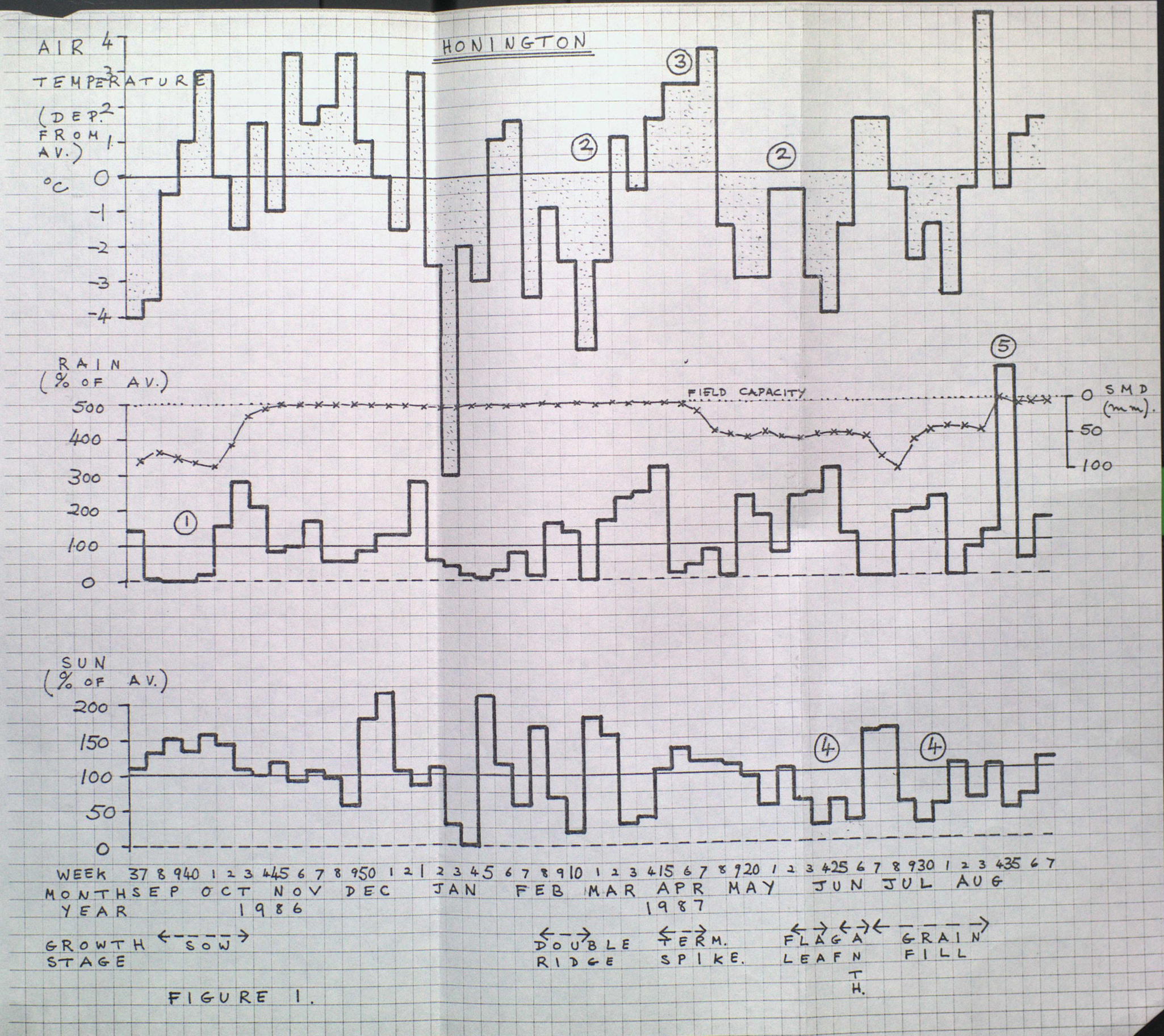
HONINGTON
AIR TEMPERATURE (DEP. FROM AV.) °C
4
3
2
1
0
-1
-2
-3
-4
RAIN (% OF AV.)
500
400
300
200
100
0
FIELD CAPACITY
0 SMD (mm).
50
100
SUN (% OF AV.)
200
150
100
50
0
① ② ③ ② ④ ④ ⑤
WEEK 37 8 9 40 1 2 3 44 5 6 7 8 9 50 1 2 1 2 3 4 5 6 7 8 9 10 1 2 3 4 15 6 7 8 9 20 1 2 3 4 25 6 7 8 9 30 1 2 3 4 35 6 7
MONTHS SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG
YEAR 1986 1987
GROWTH STAGE
SOW
DOUBLE RIDGE
TERM. SPIKE.
FLAG LEAF
A
N
TH.
GRAIN FILL

FIGURE 1.

FIGURE 2.

WINTER WHEAT, WEEKLY GROWTH CALCULATED FOR HONINGTON